

Cost Behavior and Cost-Volume-Profit Analysis

Chapter 21

Wild and Shaw

**Fundamental Accounting
Principles**

25th Edition

Chapter 21 Learning Objectives

CONCEPTUAL

- C1** Describe different types of cost behavior in relation to production and sales volume.
- C2** Describe several applications of cost-volume-profit analysis.

ANALYTICAL

- A1** Compute the contribution margin and describe what it reveals about a company's cost structure.
- A2** Analyze changes in sales using the degree of operating leverage.

PROCEDURAL

- P1** Estimate costs using the scatter diagram, high-low method, and regression.
- P2** Compute the break-even point for a single-product company.
- P3** Compute the break-even point for a multiproduct company.
- P4** *Appendix 21B*—Compute unit cost and income under both absorption and variable costing.

Learning Objective C1

Describe different types
of cost behavior in
relation to production
and sales volume.

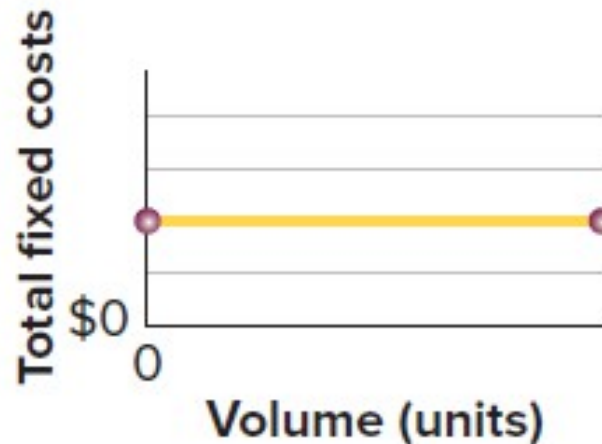
Identifying Cost Behavior

Managers use cost-volume-profit analysis to make predictions such as:

- How many units must we sell to break even?
- What sales volume is needed to earn a target income?
- How much will income change if we buy a new machine to reduce labor costs?
- What is the change in income if selling prices decline and sales volume increases?
- How will income change if we change the sales mix of our products or services?

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

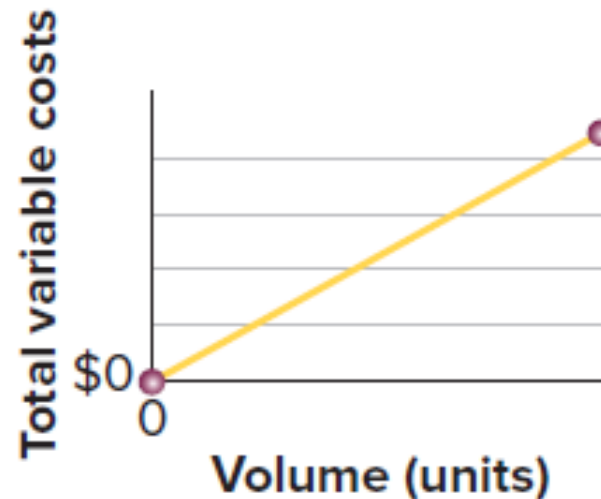
Fixed Costs



- **Total fixed costs do not change as volume changes.**
- **Unit fixed costs decreases as volume increases.**

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Variable Costs



- **Total variable costs change in proportion to volume changes.**
- **Unit variable costs stay the same as volume changes.**

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Graphing Fixed and Variable Costs

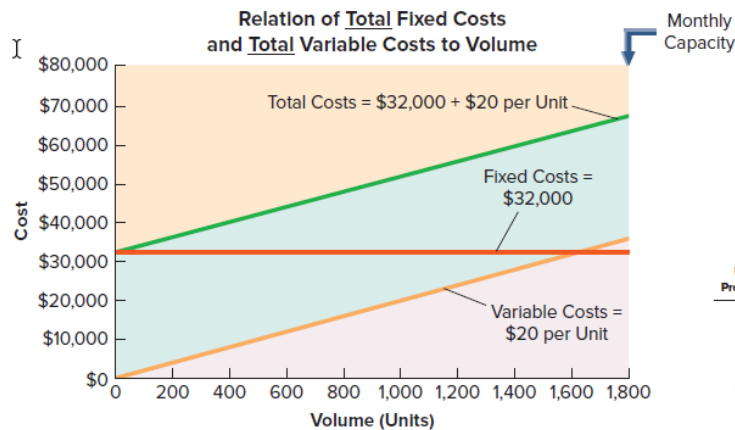
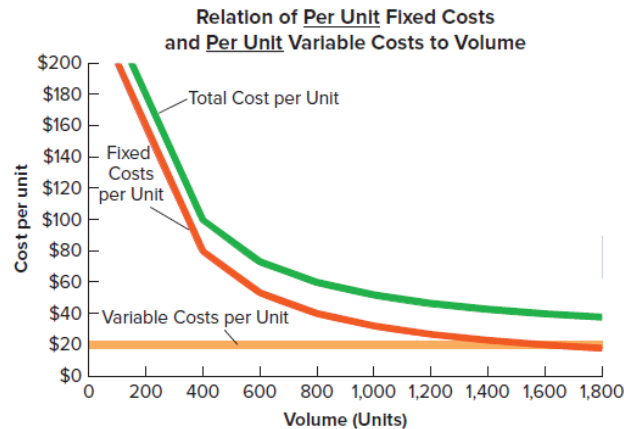
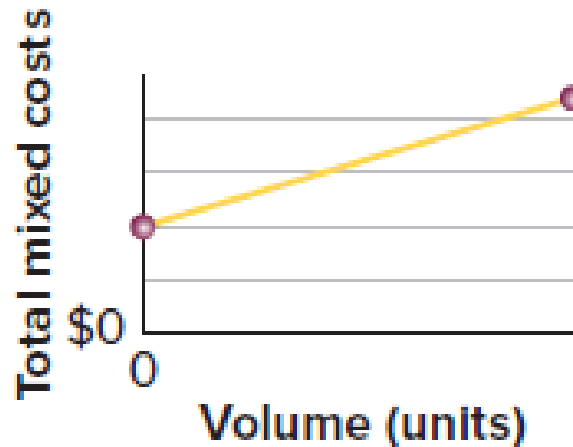


Exhibit
21.1



Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Mixed Costs



- **Mixed costs include both fixed and variable cost components.**
- **Mixed costs is greater than zero when volume is zero (fixed component) and increases steadily in proportion to increases in volume (variable component).**

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Step-Wise Costs

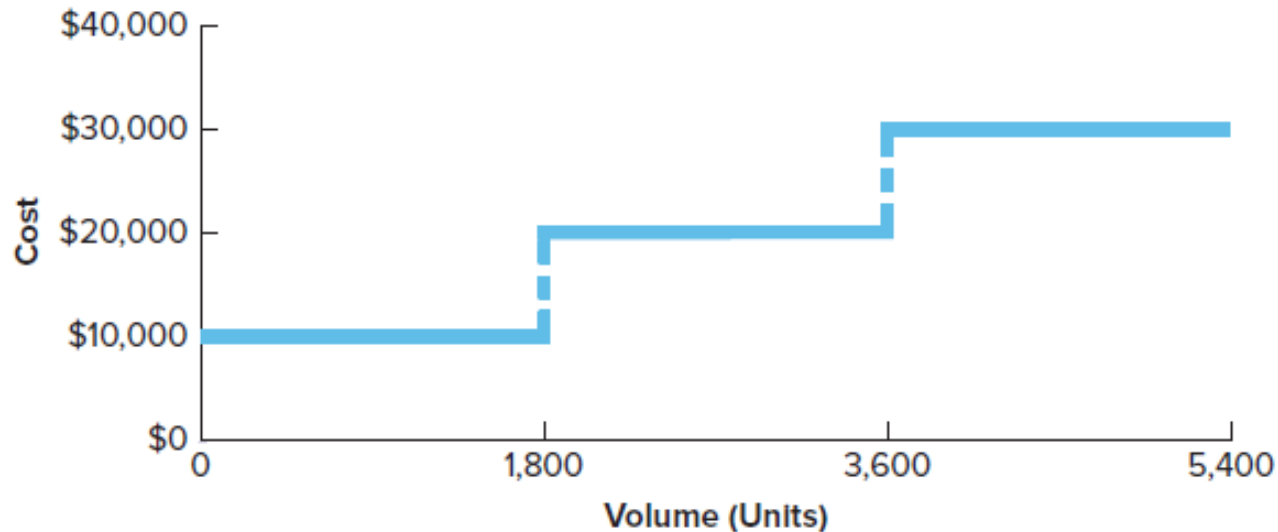


Exhibit 21.2

- **Step-wise cost has a step pattern in costs within a relevant range of current production volume.**
- **Relevant range is the normal operating range for a business.**

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Cost Examples

Exhibit 21.3

Fixed Costs	Variable Costs	Mixed Costs	Step-wise Costs
Rent	Direct materials	Sales rep (salary plus commission)	Add or drop a shift of workers
Property taxes	Direct labor	Natural gas	Add or drop a production line
Insurance	Packaging	Maintenance	Add or drop a warehouse
Office salaries	Shipping	Electricity	Add or drop a sales region
Depreciation*	Indirect materials	Water	

Learning Objective C1: Describe different types of cost behavior in relation to production and sales volume.

Learning Objective P1

Estimate costs using the scatter diagram, high-low method, and regression.

Measuring Cost Behavior

CVP analysis identifies and measures costs using fixed and variable components.

Three methods to estimate fixed and variable costs:

1. Scatter Diagram

2. High-Low Method

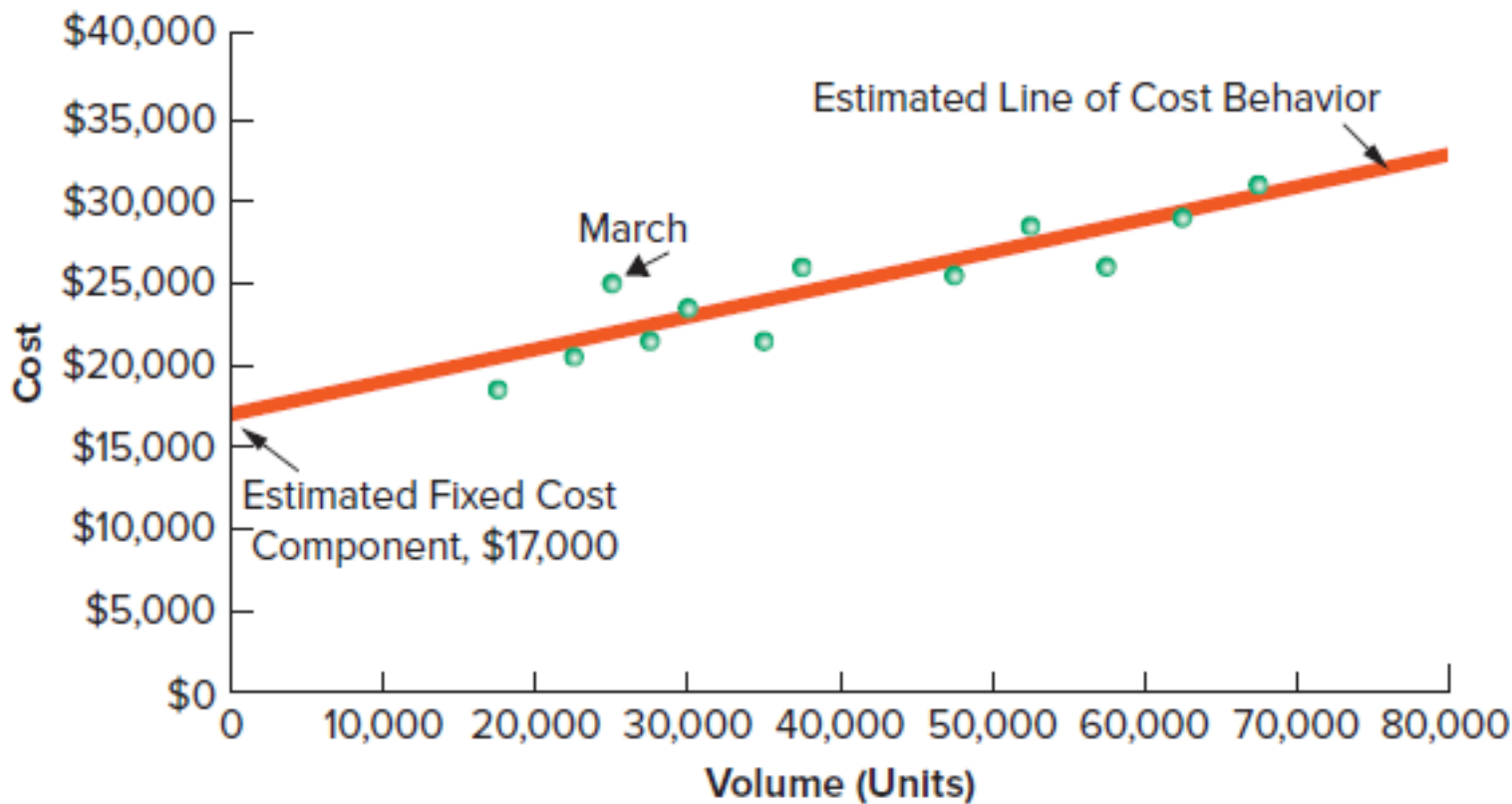
3. Regression

Exhibit 21.4

Month	Units Produced	Total Cost	Month	Units Produced	Total Cost
January	27,500	\$21,500	July	30,000	\$23,500
February	22,500	20,500	August	52,500	28,500
March	25,000	25,000	September	37,500	26,000
April	35,000	21,500	October	62,500	29,000
May	47,500	25,500	November	67,500	31,000

Scatter Diagram

Exhibit 21.5



Learning Objective P1: Estimate costs using the scatter diagram, high-low method, and regression.

The High-Low Method

The following relationships between units produced and total cost are observed:

Exhibit 21.4

Month	Units Produced	Total Cost	Month	Units Produced	Total Cost
January	27,500	\$21,500	July	30,000	\$23,500
February	22,500	20,500	August	52,500	28,500
March	25,000	25,000	September	37,500	26,000
April	35,000	21,500	October	62,500	29,000
May	47,500	25,500	November	67,500	31,000
June	17,500	18,500	December	57,500	26,000

The high-low method uses just two points to estimate the cost equation: the highest and lowest volume levels.

Learning Objective P1: Estimate costs using the scatter diagram, high-low method, and regression.

The High-Low Method Example

Month	Units Produced	Total Cost	Month	Units Produced	Total Cost
January	27,500	\$21,500	July	30,000	\$23,500
February	22,500	20,500	August	52,500	28,500
March	25,000	25,000	September	37,500	26,000
April	35,000	21,500	October	62,500	29,000
May	47,500	25,500	November	67,500	31,000

Exhibits
21.4, 21.6
& 21.7

Variable cost per unit = $\frac{\text{Cost at highest volume} - \text{Cost at lowest volume}}{\text{Highest volume} - \text{Lowest volume}} = \frac{\$31,000 - \$18,500}{67,500 - 17,500} = \$0.25 \text{ per unit}$

Total cost = Fixed cost + (Variable cost per unit × Units)

$\$31,000 = \text{Fixed cost} + (\$0.25 \text{ per unit} \times 67,500 \text{ units})$

$\$31,000 = \text{Fixed cost} + \$16,875$

$\$14,125 = \text{Fixed cost}$

Total cost = Fixed cost + (Variable cost per unit × Units)

$\$18,500 = \text{Fixed cost} + (\$0.25 \text{ per unit} \times 17,500 \text{ units})$

$\$18,500 = \text{Fixed cost} + \$4,375$

$\$14,125 = \text{Fixed cost}$

Total cost = \$14,125 + \$0.25 per unit produced

Learning Objective P1: Estimate costs using the scatter diagram, high-low method, and regression.

Regression

Regression is covered in Appendix 21A. It is commonly used with spreadsheet programs or calculators.

The objective of the cost analysis remains the same: determination of total fixed cost and the variable unit cost.

Learning Objective P1: Estimate costs using the scatter diagram, high-low method, and regression.

Comparing Cost Estimation Methods

Exhibit
21.8

Estimation Method	Fixed Cost	Variable Cost
High-low	\$14,125	\$0.25 per unit
Regression	16,688	0.20 per unit

Learning Objective P1: Estimate costs using the scatter diagram, high-low method, and regression.

Learning Objective A1

Compute the contribution margin and describe what it reveals about a company's cost structure.

Contribution Margin

Exhibit 21.9

Contribution margin per unit = Selling price per unit - Variable costs per unit

Exhibit 21.10

Contribution margin ratio = $\frac{\text{Contribution margin per unit}}{\text{Selling price per unit}}$ or $\frac{\text{Contribution margin}}{\text{Sales}}$

Selling price per unit	\$100		
Variable costs per unit	<u>70</u>		
Contribution margin per unit	<u>\$30</u>	Contribution margin ratio	30%
		(\$30/\$100)	

Learning Objective A1: Compute the contribution margin and describe what it reveals about a company's cost structure.

Learning Objective P2

Compute the break-even point for a single-product company.

Break-Even Point

Sales level where total sales equal total costs, resulting in zero income.

Can be stated in units or dollars of sales.

Three methods to find break-even point:

- Formula method
- Contribution margin income statement
- Cost-volume-profit chart

Formula Method

Exhibit
21.11

$$\text{Break-even point in units} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}} = \frac{\$24,000}{\$30} = 800 \text{ units}$$

Exhibit
21.12

$$\text{Break-even point in dollars} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}} = \frac{\$24,000}{30\% \text{ or } 0.30} = \$80,000 \text{ sales}$$

Learning Objective P2: Compute the break-even point for a single-product company.

Contribution margin income statement method

Exhibit
21.13

Contribution Margin Income Statement Format

Sales
– Variable costs

Contribution margin
– Fixed costs

Income

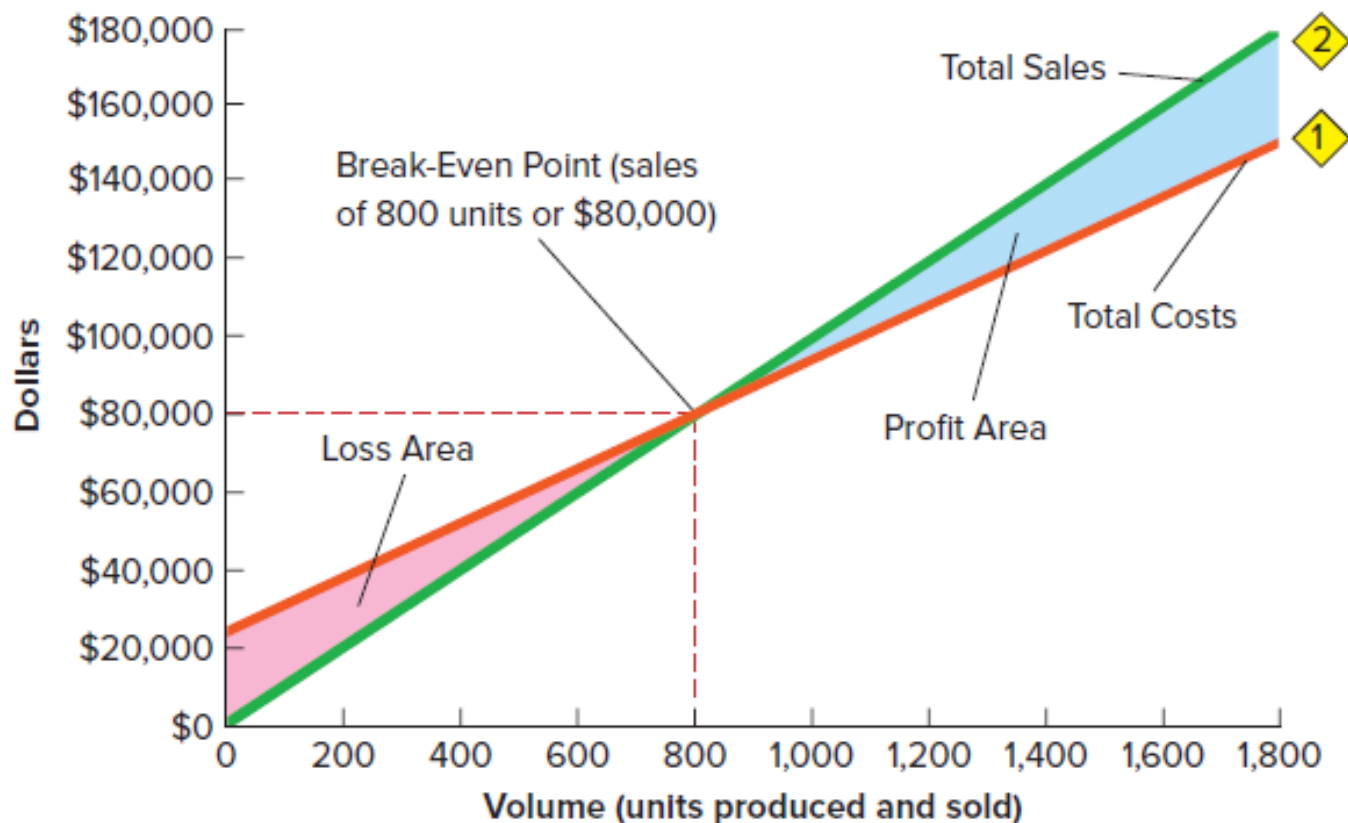
Contribution Margin Income Statement (at Break-Even) For Month Ended January 31

Sales (800 units at \$100 each)	\$80,000
Variable costs (800 units at \$70 each)	<u>56,000</u>
Contribution margin (800 units at \$30 each)	24,000
Fixed costs	<u>24,000</u>
Income	<u>\$ 0</u>

Learning Objective P2: Compute the break-even point for a single-product company.

Cost-Volume-Profit Chart

Exhibit
21.14



Learning Objective P2: Describe and record the flow of labor costs in job order costing.

Changes in Estimates

Exhibit
21.15

	Selling Price per Unit	Variable Cost per Unit	Contribution Margin per Unit	Total Fixed Costs	Break-Even in Units
Most likely	\$100	\$70	\$30	\$24,000	800
Pessimistic	96	72	24	27,000	

Exhibit
21.16

$$\text{Revised break-even point in units} = \frac{\$27,000}{\$24} = 1,125 \text{ units}$$

Exhibit
21.17

Sales Price per Unit	Break-Even
Increases →	Decreases
Decreases →	Increases

Variable Cost per Unit	Break-Even
Increases →	Increases
Decreases →	Decreases

Fixed Cost in Total	Break-Even
Increases →	Increases
Decreases →	Decreases

Learning Objective P2: Compute the break-even point for a single-product company.

Learning Objective C2

Describe several applications of cost-volume-profit analysis.

Margin of Safety

Exhibit
21.18

$$\text{Margin of safety (in percent)} = \frac{\text{Expected sales} - \text{Break-even sales}}{\text{Expected sales}} = \frac{\$100,000 - \$80,000}{\$100,000} = 20\%$$

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Computing Income from Expected Sales and Costs

Exhibit
21.19

Contribution Margin Income Statement For Month Ended January 31

Sales (1,500 units at \$100 each)	\$150,000
Variable costs (1,500 units at \$70 each)	<u>105,000</u>
Contribution margin (1,500 units at \$30 each)	45,000
Fixed costs	<u>24,000</u>
Income	<u>\$ 21,000</u>

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Computing Sales for a Target Income – Dollars

Exhibit
21.20

$$\text{Dollar sales at target income} = \frac{\text{Fixed costs} + \text{Target income}}{\text{Contribution margin ratio}} = \frac{\$24,000 - \$12,000}{30\% \text{ or } 0.30} = \$120,000$$

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Computing Sales for a Target Income – Units

Exhibit
21.21

$$\text{Unit sales at target income} = \frac{\text{Fixed costs} + \text{Target income}}{\text{Contribution margin per unit}} = \frac{\$24,000 - \$12,000}{30\%} = 1,200 \text{ units}$$

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Contribution Margin Income Statement

Exhibit
21.22

Work backwards
to find sales



Contribution Margin Income Statement For Month Ended January 31		
	Step 1	Step 2
Sales	?	\$120,000
Variable costs	<u>?</u>	<u>84,000</u>
Contribution margin	?	36,000
Fixed costs	<u>24,000</u>	<u>24,000</u>
Income (target)	<u><u>\$12,000</u></u>	<u><u>\$ 12,000</u></u>
	$\$24,000 + \$12,000$	$\$36,000 / 0.30$

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Evaluating Business Strategies

Exhibit
s
21.23,
21.24,

$$\text{Revised break-even point in dollars} = \frac{\text{Revised fixed costs}}{\text{Revised contribution margin ratio}} = \frac{\$30,000}{40\%} = \$75,000 \quad \text{\& 21.25}$$

$$\text{Revised break-even point in dollars} = \frac{\text{Revised fixed costs}}{\text{Contribution margin ratio}} = \frac{\$27,000}{30\%} = \$90,000$$

$$\text{Revised margin of safety (in percent)} = \frac{\text{Expected sales} - \text{Break-even sales}}{\text{Expected sales}} = \frac{\$125,000 - \$90,000}{\$125,000} = 28\%$$

Learning Objective C2: Describe several applications of cost-volume-profit analysis.

Learning Objective P3

Compute the break-even point for a multiproduct company.

Sales Mix and Break-Even

The CVP formulas can be modified for use when a company sells more than one product.

- The unit contribution margin is replaced with weighted-average contribution margin per unit.
- Sales mix is the proportion of sales volume for each product.

Weighted-Average Contribution Margin per Unit

	Football s	Basketb alls
Sales price per unit	\$100	\$120
Variable costs per unit	<u>70</u>	<u>85</u>
Contribution margin per unit	\$ 30	\$ 35
Sales mix percent	60%	40%

Exhibit
21.26

Exhibit
21.27

$$\begin{array}{l}
 \text{Weighted-average} \\
 \text{contribution margin} \\
 \text{per unit}
 \end{array}
 =
 \begin{array}{l}
 \text{Contribution} \\
 \text{margin per unit} \\
 \text{for each product}
 \end{array}
 \times
 \begin{array}{l}
 \text{Sales mix} \\
 \text{percent for} \\
 \text{each product}
 \end{array}
 =
 (\$30 \times 60\%) + (\$35 \times 40\%) = \$32 \text{ per unit}$$

Learning Objective P3: Compute the break-even point for a multiproduct company.

Weighted-Average Break-Even in Unit Sales

Exhibit
21.28

$$\text{Break-even point in units} = \frac{\text{Fixed costs}}{\text{Weighted-average contribution margin per unit}} = \frac{\$48,000}{\$32} = 1,500 \text{ units}$$

Exhibit
21.29

Product	Break-Even Units × Sales Mix	Unit Sales	Contribution Margin per Unit	Contrib ution Margin
Footballs	1,500 × 60%	900	\$30	\$27,000
Basketballs	1,500 × 40%	<u>600</u>	35	<u>21,000</u>
Total		<u>1,500</u>		<u>\$48,000</u>

Learning Objective P3: Compute the break-even point for a multiproduct company.

Assumptions in Cost-Volume-Profit Analysis

- Costs can be classified as variable or fixed.
- Costs are linear within the relevant range.
- Units produced are sold (inventory is constant).
- Sales mix is constant.

Learning Objective P3: Compute the break-even point for a multiproduct company.

Learning Objective A2

Analyze changes in sales
using the degree of
operating leverage.

Degree of Operating Leverage

Degree of operating leverage: a measure of the effects of change in the level of sales on income.

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Income}}$$

Exhibit
21.31

Learning Objective A2: Analyze changes in sales using the degree of operating leverage.

Operating Leverage

Rydell Company	
Sales (1,200 × \$100)	\$120,000
Variable costs (1,200 × \$70)	<u>84,000</u>
Contribution margin	36,000
Fixed costs	<u>24,000</u>
Income	<u>\$ 12,000</u>

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Income}} = \frac{\$36,000}{\$12,000} = 3.0$$

$$\text{Change in income (\%)} = \text{DOL} \times \text{Change in sales (\%)} = 3.0 \times 10\% = 30\%$$

	Current	Sales Increase by 10%	Sales Decrease by 10%
Sales	\$120,000	\$132,000	\$108,000
Variable costs	<u>84,000</u>	<u>92,400</u>	<u>75,600</u>
Contribution margin	36,000	39,600	32,400
Fixed costs	<u>24,000</u>	<u>24,000</u>	<u>24,000</u>
Income	<u>\$ 12,000</u>	<u>\$ 15,600</u>	<u>\$ 8,400</u>

Learning Objective A2: Analyze changes in sales using the degree of operating leverage

Exhibit 21-33

Exhibit 21-33

21-40

Appendix 21A: Using Excel for Cost Estimation

	A	B	C
1	Month	Units Produced	Total Cost
2	January	27,500	\$21,500
3	February	22,500	20,500
4	March	25,000	25,000
5	April	35,000	21,500
6	May	47,500	25,500
7	June	17,500	18,500
8	July	30,000	23,500
9	August	52,500	28,500
10	September	37,500	26,000
11	October	62,500	29,000
12	November	67,500	31,000
13	December	57,500	26,000
14			Result
15	Intercept	=INTERCEPT(C2:C13, B2:B13)	\$16,688.24
16	Slope	=SLOPE(C2:C13, B2:B13)	\$ 0.1995

Learning Objective P4

Compute unit cost and income under both absorption and variable costing.

Appendix 21B: Variable Costing and Performance Reporting

- **Contribution margin income statement or variable costing income statement.**
- **Variable costing - costs that change in total with changes in production levels included in product costs.**
- **Variable costs include: direct materials, direct labor, and variable overhead.**
- **Fixed overhead costs excluded from product costs.**
- **GAAP requires absorption costing - direct materials, direct labor, and all overhead (variable and fixed).**

Learning Objective 21B-1 Compute unit cost and income under both absorption and variable costing.

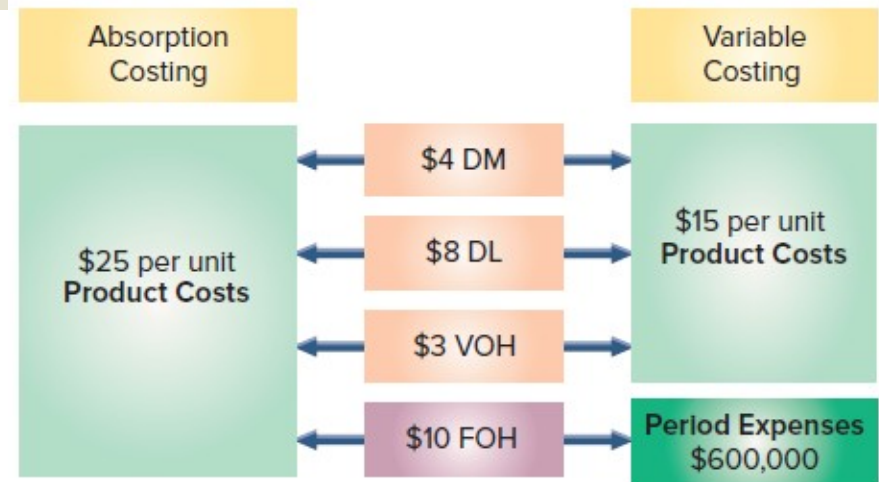
Computing Unit Cost

Exhibit
21B.1

Direct materials	\$4 per unit	Variable overhead	\$3 per unit
Direct labor	\$8 per unit	Fixed overhead	\$600,000 per year
Expected units produced per year	60,000 units		

Exhibit
21B.2

Product Cost per Unit	Absorption Costing	Variable Costing
Direct materials	\$ 4	\$ 4
Direct labor	8	8
Overhead		
Variable overhead	3	3
Fixed overhead	<u>10</u>	
Total product cost per unit	<u>\$25</u>	<u>\$15</u>



both absorption and

Income Reporting

Exhibit
21B.3

ICEAGE COMPANY Income Statement (Absorption Costing)	
Sales (40,000 × \$40)	\$1,600,000
Cost of goods sold (40,000 × \$25†)	1,000,000
Gross profit	600,000
Selling and administrative expenses	
[\$200,000 + (40,000 × \$2)]	280,000
Income	\$320,000

†\$4 DM + \$8 DL + \$3 VOH + \$10 FOH.

†\$4 DM + \$8 DL + \$3 VOH.

ICEAGE COMPANY Income Statement (Variable Costing) For Year Ended December 31			
Sales (40,000 × \$40)			\$1,600,000
Variable expenses			
Variable cost of goods sold (40,000 × \$15‡)	\$600,000		
Variable selling and administrative expenses (40,000 × \$2)	80,000	680,000	
Contribution margin			920,000
Fixed expenses			
Fixed overhead	600,000		
Fixed selling and administrative expenses	200,000	800,000	
Income			\$120,000

Learning Objective P4: Compute unit cost and income using variable costing.

Converting Income Under Variable Costing to Income under Absorption Costing

Units produced are:	Income under absorption costing is:
Equal to units sold	Equal to Income under variable costing
Greater than units sold	Greater than income under variable costing
Less than units sold	Less than income under variable costing
Income under absorption costing	Income under variable costing
	$+ \text{Fixed overhead cost in ending inventory} - \text{Fixed overhead cost in beginning inventory}$

$$\text{Income under absorption costing} = \$1,040,000 + \$0 - \$200,000 = \$840,000$$

Learning Objective P4: Compute unit cost and income under both absorption and variable costing.

End of Chapter 21